# MONTHLY NOTICES

OF THE

# ROYAL ASTRONOMICAL SOCIETY.

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PROFESSOR J. C. ADAMS, President, in the Chair.

John Locke Lancaster, Esq., 25 Hamilton Terrace, St. John's Wood, N.W.;

Francis Richard Wegg-Prosser, M.A., Belmont, Herefordshire, and 84 Eccleston Square, London, S.W., and

Prof. Charles Vencelas Zenger, Prague,

were balloted for and duly elected Fellows of the Society

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*Description of Two Old Instruments presented to the Society* by R. J. Lecky, Esq.

I have much pleasure in presenting to the Society two instruments, more curious for their antiquity and rarity than for any value they possess. They are a "Nocturnal," or Night Dial, and a Davis' Quadrant, or "Back Staff.

The inventor, as well as the date of the invention of the former, is, I believe, unknown, but the date must have been prior to the 16th century. It is a very inaccurate instrument, merely giving an approximation to the time by the position of stars in *Ursæ Major* and *Minor*

The "Back Staff" was invented about the year 1590 by a Capt. Davis, of Sandridge, near Dartmouth; who sailed to the South Seas with Cavendish; and was the first nautical instrument which had any pretension to accuracy. It is well described in Rees' *Cyclopœdia*, article, "Quadrant;" and is, indeed, the instrument from which our present sextant, and the different reflecting circles, have sprung.

Observations with this instrument give the zenith distance

of the Sun (for which, or perhaps, for a very bright Moon, it was alone useful), and were taken with the observer's back to the Sun, whence its name. The upper vane was set by estimation to a few degrees less than the zenith distance; the observer then directed his sight to the horizon, through the lower or sight vane and the horizon vane, and moved the former along its arch until the Sun's image was thrown through the lens in the upper vane on to the horizon line; when the fiducial edge of the sight vane gave, on a diagonal scale, the odd degrees and minutes, the sum of the readings of the two arches giving the correct result: a clear horizon to the north, or opposite to the Sun, being required.

Should the Society deem these worthy of acceptance, I shall be glad to have them deposited in their collection, as forming an early link in the chain of such inventions.

The Quadrant is complete, and all original, except the upper vane, which I have supplied.

The thanks of the Meeting were voted to Mr. Lecky, for his present to the Society.—Ed.

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*Note on the Erection of Mr. De La Rue's Telescopes in the New Observatory of the University of Oxford.* By Warren De La Rue, Esq.

It may be of interest to the Fellows of our Society to know that the instruments which I presented some time back to the University of Oxford are now placed in position in the New Observatory erected by that body in the Park. These instruments comprise my 13-inch reflecting Equatoreal, used by me, first at Canonbury and lastly at Cranford; a Zoneing Altazimuth with a 13-inch speculum; a polishing machine with every appliance necessary for polishing both parabolic and plane mirrors; and also Foucault's apparatus for testing mirrors. In all these are four interchangeable 13-inch mirrors, two of metal polished by myself, one of glass by Steinheil, and one of glass by With. Observations are now being made by Professor Pritchard, to enable me to make the very minute final adjustments of the Equatoreal.

While making observations for the preliminary adjustments I inadvertently used my left eye, and was surprised and delighted to find that I had recovered perfect vision with it, the granulations in the centre of the retina having disappeared.

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*On the next Oppositions of Mars for the Determination of the Solar Parallax, and the Remarkable Agreement of the Parallax obtained from the Opposition of* 1860, *with M. Cornu's New Measure of the Velocity of Light.* By M. E. Liais.

(*Translation.*)

Now that the public attention is particularly called to the solar parallax in consequence of the last transit of *Venus* over the Sun's disk, it is not without interest to notice the remarkable agreement which exists between the parallax deduced from the opposition of *Mars* in 1860, the values of the aberration of light according to the *ensemble* of the determinations of Struve, Lindenau, Lundhal, and Peters, and the new determination of the velocity of light by M. Cornu by means of observations between the Observatory of Paris and the tower of Montlhéry, which has come to my knowledge from the *Comptes Rendus* of the Academy of Sciences at Paris, of the 14th December 1874, which has just reached me.

M. Cornu has already noticed in his remarkable work that the constant of aberration determined by Struve at 20″·445, combined with the new measure of the velocity of light, gives for the solar parallax the value 8″·797, a number differing only by 0″·04 from the value 8″·760, which I deduced from my observations of the opposition of *Mars* in 1860, see *Comptes Rendus*, January 23, 1865, and my work *L'Espace Celeste*, p. 33.

The agreement is still more remarkable, if, instead of employing only the observations of Struve for the constant of aberration, we use also those of Lindenau, Lundhal, and Peters on the Pole-Star; in fact, the observations of M.M.

| | | ″ |
|---|---|---|
| Struve | give | 20·445 |
| Lindenau | ,, | 20·449 |
| Peters | ,, | 20·503 |
| Lundahl | ,, | 20·551 |
| Mean is | | 20·487 |

This mean combined with M. Cornu's value of the velocity of light gives 8″·779 for the value of the solar parallax, differing from my value 8″·760 being less than 0″·02 : an agreement which is extraordinary in relation to the great difference of the methods employed for the determination of the three elements, aberration, velocity of light, and solar parallax obtained by the opposition of *Mars*, observed from a same point on the east and the west of the meridian, by measuring with a repeating theodolite the difference of the altitudes of the planet and of a neighbouring star in a low latitude, that of Rio Janeiro, where the planet passes the meridian in the neighbourhood of the zenith.

The difference of the value which I published ten years

ago, and that deduced from the value of the aberration given by M. Peters and from M. Cornu's value of the velocity of light, is even only 0″·01, and exactly agrees with the mean of the determinations of MM. Peters and Lundahl, which give 20″·527 for the aberration.

It is right to observe that the observations of *Mars* in 1862 were not made in such favourable conditions; first, because the parallax of the planet was less in 1862 than in 1860; and secondly, because the methods employed at this epoch required the co-operation of several stations and several observers; so that the influences of the modes of pointage of the individual observers were not eliminated, as in the observations of 1860; which explains the divergency of the results obtained.

But *Mars* will be again in opposition in the month of June (1875), and, as in 1860, will pass very near the zenith of Rio Janeiro, and in conditions of nearness to the Earth similar to those of 1860. The Imperial Observatory of Rio, which has numerous instruments of precision, the setting up of which is in course of completion, will not fail to use this new opportunity of determining the solar parallax. Still better conditions will exist in 1877—epoch at which the parallax of *Mars* will attain a value sensibly equal to that of the parallax of *Venus* diminished by the solar parallax, the element to which the observations of the transit of *Venus* have reference.

The possibility of referring the position of *Mars* to that of the neighbouring stars,—while *Venus* can only be referred to the Sun's limbs, which appear subject to variations and irregularities, as indicated by the projections of the faculæ accidentally observed away from the limb, and the depressions in the neighbourhood of the spots—gives to the observations of *Mars*, in the conditions in which this planet will be in 1877, an incontestable superiority in comparison with the method which has for its object to refer the positions of *Venus* to the centre of the Sun at the times of the transits of this planet.

This opposition of 1877 will be observed at the Imperial Observatory of Rio Janeiro with greater resources than were at my disposal in 1860, and with a still larger parallax of the planet, and I thus hope for an excellent direct determination of the solar parallax; the more so in presence of the remarkable agreement which I have just called attention to between the best determinations of the aberration and the velocity of light, and the direct measure of the parallax obtained in 1860.

The observations which I propose to have made this year at the Imperial Observatory of Rio have the especial object of fixing the choice of the most perfect methods to be employed in 1877.

*Rio de Janeiro.*

*On Photography in the Transit of Venus.* By R. A. Proctor.

Mr. Christie misapprehends, it appears to me, the object of my Note on this subject: I did not desire to "raise an issue;" but, as Capt. Abney had commented on my more public statements, I thought it well to explain their real purport.

Passingly, I may express surprise that Mr. Christie considers *Venus* and the Sun likely to be equally affected by photographic irradiation. The blackness of *Venus* and of sky round Sun may be equal, but Sun's brightness near limb is very inferior to his brightness near centre. Any arrangement by which flat photographs were obtained, so far as parts of Sun not *very* near the limb were concerned, would exaggerate the difference of irradiation, for the limb itself, as compared with the edge of *Venus* in transit.

Dr. Rutherfurd, in *Papers Relating to the Transit of Venus* (Washington, 1872), says, "the photograph of the Sun will have a greater or less diameter *by many seconds of arc*, according to the energy of the rays which have produced the image; and this discrepancy may be produced by a change in the aperture, in the length of exposure, in the transparency of the atmosphere, in the hour of the day, or in the sensibility of the chemicals." To assume that the diameter of *Venus* will be affected in the same exact degree, though the conditions are so different, is somewhat unsafe. The papers from which I have just quoted dealt fully (three years ago) with all the points raised by Mr. Christie, Dr. De La Rue, and Capt. Abney, besides discussing some others which they have not mentioned. But, in any case, it would be a waste of time to discuss these points, because the examination of the photographs, if conducted without favour for preconceived opinions, must lead to a tolerably exact determination of the relative value of the various methods, the long focal, the photoheliographic, and the Daguerrean.

Referring generally to the recent transit-results, I may remark that two points seem clearly established already: (1) Contact observations, whether telescopic or photographic, have been shown not to possess the accuracy required for *improving* our estimates of the solar parallax. In 1882 transit-*chords*, and especially mid-transit observations, will have to be secured. (2) Observations with a low Sun must be avoided. I think 15° the very lowest solar altitude for effective observations; and observations with a solar altitude of 20° or 25° would be better, notwithstanding the diminution of parallax. I find, from projections which I have constructed of the next transit, that these two conditions will introduce serious geographical difficulties. In fact, the efforts necessary to secure success will be greater than the mere observation of *Venus* in transit would justify.

One circumstance of some importance in its bearing on contact observations remains to be mentioned. Referring to the

arc of light seen round the part of *Venus* outside the Sun, between the moments of external and internal contact, it was remarked at the last meeting that "an atmosphere round the planet could not account for the phenomenon, because such an atmosphere would refract the light, dispersing it between the planet and the earth, so that it could not appear as the brilliant ring described, nor retain (having passed through the refracting medium) a sufficiently active power to photograph itself." This reasoning is based on an error. A pencil of rays proceeding from any point in the Sun, and refracted by the planet's atmosphere in such a way as to reach the terrestrial observer's eye, remains appreciably a pencil of parallel rays *after* as it was *before* the refraction took place, and setting absorption aside, conveys as much light to the eye. Another pencil of equal size, passing nearer to the planet's surface would, no doubt, pass between the Earth and planet, while one passing higher in the planet's atmosphere would pass outside the Earth so to speak. The three pencils thus considered, and others intermediate to them and beyond them, are dispersed, that is, are separated from each other after refraction, and to a greater degree angularly than they were separated before refraction; but even on their original course they would have been several miles apart before reaching the Earth's distance from the Sun. No pencil of rays which setting out from a point on the Sun would, at the Earth's distance, fall on the object-glass of a telescope, would be made appreciably larger at the same distance from the Sun by being refracted through a planet's atmosphere. Indeed, it is easy to see that if the principle were correct on which that reasoning is based, we ought not to see the setting or rising Sun, as raised above the horizon by refraction. A slight extension of the consequences of this principle would also prove that, since the Sun's rays diverge in all directions, we ought never to see the Sun at all.

It will be manifest, on considering the optical conditions involved, that the light first seen by refraction round the part of *Venus's* limb most remote from the solar outline (say at ingress, after external and internal contact) must appear to form an arc coincident with the limb. This light really comes from the part of the Sun nearest to *Venus* (that is, from the part behind her disk). But as she moves further on to the Sun's disk, light from this part of the Sun, to reach the eye, must pass higher and higher above the surface of *Venus*. Nevertheless the *inner* edge of the brightening at this point will coincide with the limb, up to the moment of interior contact, unless the atmospheric refraction of *Venus* be greater than is necessary to raise the whole disk of the Sun just above the horizon of *Venus* at the time when geometrically the whole globe of the Sun is just below that horizon. But even if the atmospheric refraction for *Venus* were greater than this (though this value would exceed terrestrial refraction as 100 to 77) the apparent interval between the ring

and the disk of *Venus* would be undiscernible by the observer on the Earth, because the rays from the inside of the ring, really proceeding from the part of the Sun opposite to (that is, most remote from) the place of contact, would not pass more than a mile or two above the surface of *Venus*, on any probable hypothesis as to the refractive power of the planet's atmosphere.* The bright spot near the pole (assuming for the moment that we know the true axial position of *Venus*) might be explained as indicating clearer air over the planet's polar regions.

It was to be expected that this ring of light would be bright—brighter even than the Sun's limb. Maskelyne, in his account of the Transit of 1769,† as seen at Greenwich, recorded enough to show that *Venus* has an atmosphere, and that with a good telescope the bright ring would always be seen round the dark part of the limb, thus preventing the *exact* timing of internal contact.

*London*, 1875, *June* 10.

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*On the Application of the Method of Limiting Apertures to the Photometry of Naked-eye Stars.* By E. B. Knobel, Esq.

In making observations with the Astrometer, which I had the honor of submitting to the Society last December, it occurred to me that if I removed the silver surface of the mirror of my telescope, I should probably be able to reduce the light of naked-eye stars so much as to convert them into virtually telescopic stars—understanding by a telescopic star, one which requires an aperture larger than the pupil of the eye for its exhibition.

Taking advantage of the silver surface being somewhat broken up, I dissolved it off, and for the past six weeks have devoted myself exclusively to observations with an *unsilvered* glass mirror.

The telescope in this form does not differ materially from the instrument called a Helioscope, devised by Sir John Herschel for solar observation; but instead of employing a prism with reflection from external surface, as he suggests, I have retained the silvered plane or flat, so that the only difference made is in the silver surface of the mirror.

Though considerable advantage would have resulted from using a prism with reflection from external surface only, for the photometrical observation of the brightest stars (a method which I hope to be able to undertake at a future time,) yet my prin-

* In considering this subject it must not be forgotten that the apparent diameter of *Venus* is increased by her atmospheric refraction.

† *Phil. Trans.* 1768, p. 367.

cipal object in not making any observations under these conditions now, was that one series made with the unsilvered mirror might be readily and with certainty compared with another made with the silvered mirror, by merely knowing the ratio of light reflected at a perpendicular incidence from polished silver and the external surface of glass—incidentally also by these two series of observations to determine this ratio with some approach to accuracy.*

Using the limiting aperture Astrometer on the unsilvered mirror, I find myself able to extinguish all stars from the 1st to the 9th or 10th magnitudes, and with the silvered mirror, stars down to the 15th magnitude.

By these means of observation, therefore, I see no reason why naked-eye and telescopic stars should not be connected in one unbroken chain, and a better idea of the relative magnitudes obtained than we possess at present.

The following observations with the unsilvered mirror I can only consider as first experiments. I much regret that my astronomical observations are likely to be interrupted for some time, and, therefore, I have no reason for delaying to submit my results to the consideration of the Society.

Mr. Dawes, in his valuable researches on the Photometry of Telescopic Stars, employed as a basis the mean limiting aperture for an average 6th-magnitude star, which he found to be ·15 inch, and upon this he built up a table of limiting apertures for stars of different magnitudes. This aperture I find, by the method I have adopted, to be about the limiting aperture for the Pole star. Circular apertures so minute as ·15 inch are necessarily very difficult to construct and very difficult to measure when made; but the same aperture by the method I propose is calculated from a triangular opening, the side of which is $1\frac{1}{2}$ inch, and by the formula given with the description of the Astrometer,† the effective aperture is accurately calculated, the only error being in any want of concentricity between the triangle and the plane of the reflector.

In this elementary stage of the subject, it is impossible to generalise and combine the results of several nights. I have, therefore, kept each night's observations quite distinct, and made comparison only between those stars observed at the same date and under similar atmospheric conditions.

The first column gives the date of observation; the second, the star's name; the third gives the mean limiting aperture taken from a table kindly prepared for me at great trouble by Mr. Gray;

* Sir John Herschel gives this ratio on the authority of Bouguer as 905 : 43. The small star which forms an obtuse angle with $\epsilon$ and 5 *Lyræ* is the only star yet examined with the silvered and unsilvered mirror, and this gives a ratio of 1000 : 125. This result, however, cannot be relied on, as it is obtained from such few observations; yet I do not think the error is very great, and am inclined to suspect that Bouguer's ratio will not hold good for the polished silver surface on a glass reflector.

† *Monthly Notices*, December 1874.

the fourth column contains the number of observations; the fifth gives the Light-ratio in terms of one star selected as a unit for each night. I append a Table of Light-Ratios of Stars to tenths of magnitudes, calculated on Pogson's ratio of the amount of light received from two stars differing in brightness by one whole magnitude = 2·512. By reference to this table the relative magnitudes of each night's series may be at once ascertained. In the sixth column I give the magnitude of the star assigned by Argelander in his *Durchmusterung*. The Star-magnitudes in this work seem to be decidedly more accurate than those given in the *Uranometria Nova*.* I am confirmed in this opinion by a remark of Mr. Christie's in a recent paper on "the Brightness of Stars."† Mr. Christie selected certain standard 6th-magnitude stars, which he found Argelander called 6·0 magnitude; but his observations showed there was no such approach to equality as he had expected. On comparing, however, Argelander's magnitudes in the *Durchmusterung* with Mr. Christie's results, there is a satisfactory accordance between them for five of the seven

* The following are a few instances in support of this statement, in which U. N. shows the magnitudes assigned in the *Uranometria Nova*, and D. those of the *Durchmusterung*: L.A. being the mean limiting apertures I have obtained :—

| | U. N. | D. | L. A. Inches. |
|---|---|---|---|
| 17 Ursæ Majoris | 6·0 | 5·0 | ·52 |
| 35 Ursæ Majoris | 6·0 | 6·6 | ·81 |
| 42 Ursæ Majoris | 6·0 | 5·8 | ·54 |
| θ Ursæ Minoris | 6·5 | 5·0 | ·45 |
| 26 Draconis | 6·5 | 6·0 | ·54 |
| β Coronæ | 4·3 | 4·0 | ·40 |
| ε Coronæ | 4·0 | 4·0 | ·43 |

Comparing the limiting apertures shows at once a better accordance with the magnitudes of the *Durchmusterung* than with those of the *Uranometria Nova*.

I append also Mr. Christie's results compared with the magnitudes given in the *Uranometria Nova* and the *Durchmusterung* :—

| | U. N. | D. | Brightness. |
|---|---|---|---|
| 40 Pegasi | 6·0 | 6·0 | 80·1 |
| 52 Pegasi | 6·0 | 6·1 | 72·4 |
| 45 Pegasi | 6·0 | 6·2 | 74·4 |
| 41 Pegasi | 6·0 | 6·5 | 49·6 (Mean of two) |
| 60 Pegasi | 6·0 | 6·3 | 48·7 |

[It was suggested at the meeting that in the U.N. the magnitudes are given as 6, 6, 6, 6–5, 6–5, 4–3, 4 : viz. that 6–5, 4–3 mean somewhat brighter than 6, 4 respectively.—Ed.]

† *Monthly Notices*, January 1874.

selected stars. Indeed, only one of these stars is given in the *Durchmusterung* as of the 6·0 magnitude.

A Kellner eyepiece, power 60, was employed throughout, except for $\mu^1$ and $\mu^2$ *Boötis*, and the 9th magnitude *comes* to $\varepsilon$ and 5 *Lyræ*, when a high power was used to obviate the effect of the neighbouring bright stars.

| Date 1875. | Star. | Limiting Aperture. Inches. | No. of Obs. | Light-Ratio. | Magnitude Argelander, *Durchmusterung*. |
|---|---|---|---|---|---|
| April 27 | $\sigma^2$ Ursæ Majoris | 0·44 | 2 | 1·000 | 5·3 |
| ,, | $\sigma^1$ Ursæ Majoris | 0·54 | 2 | 0·640 | 5·2 |
| ,, | 42 Ursæ Majoris | 0·66 | 3 | 0·444 | 5·8 |
| April 28 | 27 Ursæ Majoris | 0·45 | 2 | 1·000 | 5·3 |
| ,, | $\theta$ Ursæ Minoris | 0·45 | 2 | 1·000 | 5·0 |
| ,, | 32 Ursæ Majoris | 0·47 | 2 | 0·916 | 5·8 |
| ,, | 26 Draconis | 0·50 | 2 | 0·810 | 6·0 |
| ,, | 17 Ursæ Majoris | 0·52 | 3 | 0·748 | 5·0 |
| ,, | 42 Ursæ Majoris | 0·54 | 2 | 0·694 | 5·8 |
| ,, | 6 Ursæ Majoris | 0·60 | 4 | 0·562 | 6·0 |
| ,, | 35 Ursæ Majoris | 0·81 | 2 | 0·308 | 6·6 |
| May 2 | $\mu^1$ Boötis | 0·38 | 1 | 2·576 | 4·0 |
| ,, | 14 Boötis | 0·61 | 3 | 1·000 | 6·2 |
| ,, | 18 Boötis | 0·62 | 2 | 0·968 | 5·7 |
| ,, | $\pi^1$ Ursæ Minoris | 0·73 | 3 | 0·698 | 6·8 |
| ,, | 10 Can. Ven. | 0·79 | 2 | 0·596 | 6·1 |
| ,, | 7 Leonis | 0·81 | 3 | 0·567 | 6·8 |
| ,, | 3 Messier Nebula | 0·85 | 1 | 0·515 | Nebula |
| ,, | 163 P. xiii. | 0·88 | 3 | 0·480 | 6·5 |
| ,, | $\mu^2$ Boötis | 0·90 | 1 | 0·459 | 7·0 |
| ,, | Comes to $\epsilon$ & 5 Lyræ | 3·72 | 1 | 0·026 | 9·4* |
| May 9 | $\chi$ Ursæ Majoris | 0·32 | 1 | 14·535 | 4·0 |
| ,, | Arg. 1964 Zone 48° | 1·22 | 2 | 1·000 | 7·8 |
| ,, | Arg. 1877 Zone 53° | 2·18 | 1 | 0·313 | 9·3 |
| ,, | Arg. 1874 Zone 53° | 2·30 | 2 | 0·281 | 9·5 |
| ,, | Arg. 1873 Zone 53° | 2·36 | 4 | 0·267 | 9·5 |
| ,, | Arg. 1878 Zone 53° | 2·52 | 3 | 0·234 | 9·4 |
| ,, | Comes to $\epsilon$ & 5 Lyræ | 3·45 | 4 | 0·125 | 9·4 |

* Gauged by Dawes of 9·5 Mag.

| Date 1875. | Star. | Limiting Aperture. Inches. | No. of Obs. | Light-Ratio. | Magnitude Argelander, *Durchmusterung.* |
|---|---|---|---|---|---|
| May 10 | λ Draconis | 0·30 | 4 | 1·000 | 3·3 |
| ,, | χ Ursæ Majoris | 0·32 | 1 | 0·878 | 4·0 |
| ,, | ξ Draconis | 0·36 | 3 | 0·694 | 3·5 |
| ,, | ϵ Lyræ | 0·41 | 2 | 0·535 | 4·3 |
| ,, | $\mu^1$ Boötis | 0·42 | 2 | 0·510 | 4·0 |
| ,, | ρ Ursæ Majoris | 0·42 | 1 | 0·510 | 5·1 |
| ,, | $\sigma^2$ Ursæ Majoris | 0·43 | 1 | 0·486 | 5·3 |
| ,, | θ Ursæ Minoris | 0·51 | 1 | 0·346 | 5·0 |
| ,, | $\sigma^1$ Ursæ Majoris | 0·53 | 1 | 0·320 | 5·2 |
| ,, | $\mu^2$ Boötis | 1·05 | 2 | 0·0816 | 7·0 |
| ,, | 13 Messier Nebula | 1·20 | 1 | 0·062 | Nebula |
| ,, | Arg. 480 Zone 78° | 2·81 | 1 | 0·014 | 0·4 |
| ,, | Arg. 1969 Zone 48° | 3·18 | 1 | 0·0089 | 9·5 |
| ,, | Comes to ϵ & 5 Lyræ | 3·31 | 1 | 0·0082 | 9·4 |
| May 13 | α Draconis | 0·26 | 3 | 1·273 | 3·4 |
| ,, | ϵ Lyræ | 0·31 | 1 | 1·000 | 4·3 |
| ,, | ξ Draconis | 0·32 | 2 | 0·938 | 3·5 |
| ,, | ζ Ursæ Minoris | 0·36 | 2 | 0·741 | 4·7 |
| ,, | ψ Boötis | 0·38 | 3 | 0·665 | 4·7 |
| ,, | λ Draconis | 0·39 * | 2 | 0·631 | 3·3 |
| ,, | 45 Boötis | 0·41 | 3 | 0·571 | 4·8 |
| ,, | μ Draconis | 0·42 | 2 | 0·544 | 4·8 |
| ,, | $\nu^1$ Coronæ | 0·43 | 2 | 0·519 | 5·2 |
| ,, | θ Ursæ Minoris | 0·45 | 1 | 0·474 | 5·0 |
| ,, | ω Boötis | 0·50 | 2 | 0·384 | 4·7 |
| ,, | 26 Draconis | 0·54 | 1 | 0·329 | 6·0 |
| ,, | 73 Ursæ Majoris | 0·55 | 1 | 0·317 | 6·0 |
| ,, | 19 Ursæ Minoris | 0·56 | 3 | 0·306 | 6·0 |
| ,, | 38 Boötis | 0·63 | 1 | 0·242 | 6·0 |
| ,, | 6 Ursæ Majoris | 0·65 | 2 | 0·227 | 6·0 |
| ,, | 70 Ursæ Majoris | 0·66 | 1 | 0·220 | 6·0 |
| ,, | Comes to ϵ & 5 Lyræ | 3·26 | 1 | 0·0090 | 9·4 |
| May 15 | Arcturus | 0·040 | 3 | 30·250 | 1·0 |
| ,, | α Lyræ | 0·058 | 3 | 14·387 | 1·0 |
| ,, | γ Draconis | 0·22 | 2 | 1·000 | 2·2 |

* Affected by bright moon.

| Date 1875. | Star. | Limiting Aperture. Inches. | No. of Obs. | Light-Ratio. | Magnitude Argelander, *Durchmusterung*. |
|---|---|---|---|---|---|
| May 15 | $\chi$ Draconis | 0·27 | 3 | 0·663 | 3·8 |
| ,, | $\delta$ Draconis | 0·28 | 2 | 0·617 | 3·4 |
| ,, | $\alpha$ Draconis | 0·30 | 4 | 0·537 | 3·4 |
| ,, | $\iota$ Draconis | 0·30 | 2 | 0·537 | 3·0 |
| ,, | $\iota$ Herculis | 0·32 | 4 | 0·472 | 4·0 |
| ,, | $\xi$ Draconis | 0·33 * | 1 | 0·444 | 3·5 |
| ,, | $\phi$ Draconis | 0·33 | 2 | 0·444 | 4·7 |
| ,, | $\xi$ Draconis | 0·35 † | 2 | 0·395 | 3·5 |
| ,, | $\psi$ Draconis | 0·39 | 2 | 0·318 | 4·8 |
| ,, | $\psi$ Boötis | 0·49 ‡ | 1 | 0·201 | 4·7 |
| ,, | $\omega$ Boötis | 0·56 ‡ | 1 | 0·154 | 4·7 |
| ,, | 45 Boötis | 0·59 ‡ | 1 | 0·139 | 4·8 |
| May 16 | Arcturus | 0·047 § | 8 | 1·000 | 1·0 |
| ,, | $\alpha$ Lyræ | 0·064 | 11 | 0·529 | 1·0 |
| ,, | $\alpha$ Cygni | 0·097 | 8 | 0·234 | 1·7 |
| ,, | $\beta$ Ursæ Minoris | 0·145 | 8 | 0·105 | 2·1 |
| ,, | Polaris | 0·154 | 8 | 0·093 | 2·0 |
| May 31 | $\epsilon$ Lyræ | 0·38 | 2 | 1·000 | 4·3 |
| ,, | $\mu^1$ Boötis | 0·46 | 6 | 0·682 | 4·0 |
| ,, | $\psi$ Boötis | 0·48 | 4 | 0·626 | 4·7 |
| ,, | $\omega$ Boötis | 0·56 | 3 | 0·460 | 4·7 |
| ,, | $\mu^2$ Boötis | 1·12 | 1 | 0·115 | 7·0 |
| June 1 | $\zeta$ Ursæ Minoris | 0·32 | 3 | 1·000 | 4·7 |
| ,, | $\delta$ Ursæ Minoris | 0·33 | 3 | 0·940 | 4·5 |
| ,, | $\epsilon$ Ursæ Minoris | 0·33 | 3 | 0·940 | 4·0 |
| ,, | 5 Ursæ Minoris | 0·38 | 3 | 0·709 | 5·0 |
| ,, | $\mu$ Boötis | 0·40 | 4 | 0·640 | 4·0 |
| , | $\eta$ Ursæ Minoris | 0·41 | 2 | 0·609 | 5·3 |
| ,, | 4 Ursæ Minoris | 0·44 | 2 | 0·528 | 5·0 |
| ,, | $\psi$ Boötis | 0·50 | 3 | 0·409 | 4·7 |
| ,, | 45 Boötis | 0·50 | 2 | 0·409 | 4·8 |
| ,, | 19 Ursæ Minoris | 0·51 | 3 | 0·393 | 6·0 |
| ,, | $\omega$ Boötis | 0·58 | 2 | 0·304 | 4·7 |

* Unaffected by moon.
† Affected by moonlight.
‡ Strongly affected by moonlight.
§ Moon 30° from *Arcturus*, affecting it more than $\alpha$ *Lyræ*.

| Date 1875. | Star. | Limiting Aperture. Inches. | No. of Obs. | Light-Ratio. | Magnitude Argelander, *Durchmusterung.* |
|---|---|---|---|---|---|
| June 4 | $\alpha$ Coronæ | 0·24 | 3 | 1·000 | 2·0 |
| ,, | $\gamma$ Coronæ | 0·35 | 3 | 0·470 | 4·0 |
| ,, | $\theta$ Coronæ | 0·36 | 3 | 0·444 | 4·2 |
| ,, | $\beta$ Coronæ | 0·40 | 3 | 0·360 | 4·0 |
| ,, | $\epsilon$ Coronæ | 0·43 | 4 | 0·311 | 4·0 |
| ,, | $\delta$ Coronæ | 0·50 | 4 | 0·230 | 4·5 |
| ,, | $\iota$ Coronæ | 0·59 | 4 | 0·165 | 5·0 |
| ,, | $\eta$ Coronæ | 0·66 | 4 | 0·132 | 5·2 |

April 27. Fair night; little haze; no moon.
,, 28. Very fine night; remarkably clear.
May 2. Fair night; little haze.
,, 9. Fine bright night; west wind.
,, 10. Fine and steady; Moon's age, five days.
,, 13. Bright moon, eight days old.
,, 15. Moon very bright, ten days old.
,, 16. Fair night; east wind; bright moon.
,, 31. East wind; haze; observations difficult from ill health.
June 1. Fine clear night; east wind.
,, 4. Hazy night; westerly wind.

Several anomalies and contradictions are almost inseparable from such observations, which I attribute rather to physiological than to atmospheric causes, but with the majority of cases a satisfactory accordance will be found.

The two stars $\mu^1$ and $\mu^2$ *Boötis* were examined on three nights, giving a difference of magnitude of 1·9, 2·0, and 1·9 respectively, Smyth makes a magnitude-difference of 4·0, and Argelander 3·0 between these stars: both estimates are quite irreconcilable with what I have obtained. $\xi$ *Draconis* and the 9th-magnitude star which forms an obtuse angle with $\epsilon$ and 5 *Lyræ* gave a magnitude-difference of 4·8 one night and 5·0 on another. $\chi$ *Ursæ Majoris* and the same small star gave magnitude-differences on two nights of 5·1 and 5·0 respectively.

The two stars $\psi$ and $\omega$ *Boötis* gave on three out of four the same magnitude-difference, viz.: 0·3. These stars are rated by Argelander of exactly equal magnitudes.

14 *Boötis* and 18 *Boötis* were gauged of the same magnitude, and on that night there was no apparent difference to the naked eye. Argelander makes 0·5 magnitude-difference between them, and in Proctor's *Atlas* they are marked one of the 5th and the other of the 6th magnitude. As these stars are close together and eye-comparison is easy, it is difficult to understand the discrepancy even of half a magnitude, unless there has been

change: it is, therefore, possible that the star 14 *Boötis* may turn out to be a variable.

Comparison made between observations of *Arcturus* and *Vega* on two nights, gave on May 15, a magnitude-difference of 0·8; and on the following night, from a larger series of observations, but when *Arcturus* was more affected than *Vega* by the neighbouring moon, a magnitude-difference of 0·7.

I do not think much weight can be given to the *actual* limiting apertures, which are very minute for these particular stars, as any want of concentricity in the triangular opening and the diagonal plane of the telescope would affect them so largely. I do not think, however, there is much error in the *relative* apertures, and, consequently, in the relative magnitudes.

But the consideration of stars of the first magnitude may be better left to the observations I hope to be able to undertake, reducing the light still more, by using, in the place of the diagonal plane, a prism, with reflection from external surface only, and thus necessitating a larger limiting aperture.

*Stapenhill, Burton-on-Trent.*
1875, *June* 5.

*Table of Light-Ratios of Stars in terms of a 6th-Magnitude Star.*
*Pogson's ratio* $R = 2{\cdot}512$.

| Mag. | L.R. | Mag. | L.R. | Mag. | L.R. |
|---|---|---|---|---|---|
| 1·0 | 100·000 | 5·1 | 2·291 | 9·2 | 0·05249 |
| 1·1 | 91·210 | 5·2 | 2·090 | 9·3 | 0·04787 |
| 1·2 | 83·190 | 5·3 | 1·906 | 9·4 | 0·04366 |
| 1·3 | 75·870 | 5·4 | 1·738 | 9·5 | 0·03981 |
| 1·4 | 69·190 | 5·5 | 1·585 | 9·6 | 0·03631 |
| 1·5 | 63·100 | 5·6 | 1·445 | 9·7 | 0·03312 |
| 1·6 | 57·550 | 5·7 | 1·318 | 9·8 | 0·03020 |
| 1·7 | 52·490 | 5·8 | 1·202 | 9·9 | 0·02755 |
| 1·8 | 47·870 | 5·9 | 1·096 | 10·0 | 0·02512 |
| 1·9 | 43·660 | 6·0 | 1·000 | 10·1 | 0·02291 |
| 2·0 | 39·810 | 6·1 | 0·9121 | 10·2 | 0·02090 |
| 2·1 | 36·310 | 6·2 | 0·8319 | 10·3 | 0·01906 |
| 2·2 | 33·120 | 6·3 | 0·7587 | 10·4 | 0·01738 |
| 2·3 | 30·200 | 6·4 | 0·6919 | 10·5 | 0·01585 |
| 2·4 | 27·550 | 6·5 | 0·6310 | 10·6 | 0·01445 |
| 2·5 | 25·120 | 6·6 | 0·5755 | 10·7 | 0·01318 |
| 2·6 | 22·910 | 6·7 | 0·5249 | 10·8 | 0·01202 |
| 2·7 | 20·900 | 6·8 | 0·4787 | 10·9 | 0·01096 |
| 2·8 | 19·060 | 6·9 | 0·4366 | 11·0 | 0·01000 |
| 2·9 | 17·380 | 7·0 | 0·3981 | 11·1 | 0·00912 |
| 3·0 | 15·850 | 7·1 | 0·3631 | 11·2 | 0·00832 |

| Mag. | L.R. | Mag. | L.R. | Mag. | L.R. |
|---|---|---|---|---|---|
| 3·1 | 14·450 | 7·2 | 0·3312 | 11·3 | 0·00758 |
| 3·2 | 13·180 | 7·3 | 0·3020 | 11·4 | 0·00691 |
| 3·3 | 12·030 | 7·4 | 0·2755 | 11·5 | 0·00631 |
| 3·4 | 10·965 | 7·5 | 0·2512 | 11·6 | 0·00575 |
| 3·5 | 10·000 | 7·6 | 0·2291 | 11·7 | 0·00525 |
| 3·6 | 9·121 | 7·7 | 0·2090 | 11·8 | 0·00478 |
| 3·7 | 8·319 | 7·8 | 0·1906 | 11·9 | 0·00436 |
| 3·8 | 7·587 | 7·9 | 0·1738 | 12·0 | 0·00398 |
| 3·9 | 6.919 | 8·0 | 0·1585 | 12·1 | 0·00363 |
| 4·0 | 6·310 | 8·1 | 0·1445 | 12·2 | 0·00331 |
| 4·1 | 5·755 | 8·2 | 0·1318 | 12·3 | 0·00302 |
| 4·2 | 5·249 | 8·3 | 0·1203 | 12·4 | 0·00275 |
| 4·3 | 4·787 | 8·4 | 0·1096 | 12·5 | 0·00251 |
| 4·4 | 4·366 | 8·5 | 0·1000 | 12·6 | 0·00226 |
| 4·5 | 3·981 | 8·6 | 0·09121 | 12·7 | 0·00209 |
| 4·6 | 3·631 | 8·7 | 0·08319 | 12·8 | 0·00190 |
| 4·7 | 3·312 | 8·8 | 0·07587 | 12·9 | 0·00173 |
| 4·8 | 3·020 | 8·9 | 0·06919 | 13·0 | 0·00158 |
| 4·9 | 2·755 | 9·0 | 0·06310 | | |
| 5·0 | 2·512 | 9·1 | 0·05755 | | |

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*Comparison of the R.A. and Decl. of Standard Stars observed at the Radcliffe Observatory, Oxford, in the year* 1872, *with the Tabular R.A. and Decl. of the same Stars from the "Berliner Jahrbuch."* By Prof. Dr. F. Ph. Wolfers.

(*Communicated by the Radcliffe Observer.*)

| Name of Star. | Num. of Obs. | R.A. 1872 Oxford. | R.A. 1872 Ber. Jahr. | O.−B.J. | Num. of Obs. | Decl. 1872 Oxford. | Decl. 1872 Ber. Jahr. | O.−B.J. |
|---|---|---|---|---|---|---|---|---|
| α Andromedæ | 5 | 0 1 46·42 | 46·47 | −0·05 | 8 | +28 23 0·45 | 2·25 | −1·80 |
| γ Pegasi | 7 | 0 6 38·78 | 38·85 | −0·07 | 7 | +14 28 17·31 | 18·96 | −1·65 |
| α Cassiopeiæ | 1 | 0 33 15·61 | 15·36 | +0·25 | 6 | +55 50 3·43 | 6·19 | −2·76 |
| [β Ceti] | 1 | 0 37 9·66 | 9·80 | −0·14 | 1 | −18 41 23·71 | 23·54 | −0·17 |
| α Arietis | 4 | 1 59 57·70 | 57·73 | −0·03 | 5 | +22 51 21·16 | 22·17 | −1·01 |
| [γ Ceti] | 2 | 2 36 40·15 | 40·24 | −0·09 | 3 | + 2 41 41·68 | 41·84 | −0·16 |
| α Ceti | 2 | 2 55 35·39 | 35·41 | −0·02 | 3 | + 3 35 9·69 | 9·37 | +0·32 |
| α Persei | — | ... | ... | ... | 15 | +49 24 11·21 | 11·50 | −0·29 |
| α Tauri | 4 | 4 28 34·69 | 34·69 | 0·00 | 7 | +16 14 58·59 | 60·19 | −1·60 |
| α Aurigæ | 2 | 5 7 13·98 | 14·23 | −0·25 | 4 | +45 51 53·68 | 53·74 | −0·06 |
| β Orionis | 3 | 5 8 23·11 | 23·28 | −0·17 | 2 | − 8 21 6·13 | 5·65 | −0·48 |
| β Tauri | 6 | 5 18 12·17 | 12·14 | +0·03 | 15 | +28 29 48·52 | 47·64 | +0·88 |

| Name of Star. | Num. of Obs. | R.A. 1872 Oxford. | R.A. 1872 Ber. Jahr. | O.−B.J. | Num. of Obs. | Decl. 1872 Oxford. | Decl. 1872 Ber. Jahr. | O.−B.J. |
|---|---|---|---|---|---|---|---|---|
| α Orionis | — | ... | ... | ... | 3 | + 7 22 51·39 | 50·91 | +0·48 |
| α Canis Maj. | 4 | 6 39 30·43 | 30·24 | +0·19 | 4 | −16 32 33·57 | 34·90 | +1·33 |
| α Geminorum | 4 | 7 26 25·72 | 25·73 | −0·01 | 10 | +32 10 0·28 | 0·28 | 0·00 |
| α Canis Min. | 2 | 7 32 35·91 | 35·90 | +0·01 | 4 | + 5 33 3·20 | 3·72 | −0·52 |
| β Geminorum | 7 | 7 37 28·82 | 28·89 | −0·07 | 9 | +28 19 59·10 | 59·23 | −0·13 |
| [γ′ Leonis] | 4 | 10 12 54·74 | 54·77 | −0·03 | 6 | +20 29 16·61 | 17·32 | −0·71 |
| γ Ursæ Maj. | 3 | 11 47 5·33 | 5·39 | −0·06 | 11 | +54 24 22·28 | 22·91 | −0·63 |
| [α Can. Ven.] | — | ... | ... | ... | 2 | +39 0 35·41 | 36·74 | −1·33 |
| α Virginis | 1 | 13 18 27·03 | 27·14 | −0·11 | 1 | −10 29 32·09 | 32·57 | +0·48 |
| [ζ Virginis] | 7 | 13 28 10·34 | 10·49 | −0·15 | 6 | + 0 3 33·05 | 35·69 | −2·64 |
| [η Boötis] | 5 | 13 48 35·38 | 35·55 | −0·17 | 19 | +19 2 24·67 | 25·54 | −0·87 |
| α Boötis | 13 | 14 9 49·44 | 49·43 | +0·01 | 25 | +19 50 59·20 | 60·63 | −1·43 |
| $\alpha^2$ Libræ | 8 | 14 43 47·97 | 48·03 | −0·06 | 7 | −15 30 29·91 | 29·13 | −0·78 |
| β Ursæ Min. | 7 | 14 51 6·11 | 6·17 | −0·06 | 27 | +74 40 42·12 | 41·12 | +1·00 |
| α Coronæ | 6 | 15 29 16·10 | 16·18 | −0·08 | 16 | +27 8 48·63 | 50·14 | −1·51 |
| α Serpentis | 3 | 15 37 57·75 | 57·89 | −0·14 | 3 | + 6 49 47·36 | 48·78 | −1·42 |
| [ζ Ursæ Min.] | — | ... | ... | ... | 5 | +78 11 13·96 | 13·73 | +0·23 |
| α Scorpii | 2 | 16 21 33·77 | 33·74 | +0·03 | 4 | −26 8 42·87 | 43·19 | +0·32 |
| [ζ α Herculis] | 3 | 16 36 27·52 | 27·88 | −0·36 | 8 | +31 50 10·42 | 9·31 | +1·11 |
| α Herculis | 8 | 17 8 48·64 | 48·75 | −0·11 | 8 | +14 32 17·32 | 17·95 | −0·63 |
| [β Draconis] | — | ... | ... | ... | 4 | +52 23 48·25 | 49·31 | −1·06 |
| α Ophiuchi | 5 | 17 28 59·56 | 59·61 | −0·05 | 9 | +12 39 17·95 | 19·57 | −1·62 |
| [μ Herculis] | 6 | 17 41 26·96 | 26·95 | +0·01 | 16 | +27 47 49·84 | 51·55 | −1·71 |
| [β Lyræ] | 8 | 18 45 21·28 | 21·26 | +0·02 | 9 | +33 12 56·53 | 55·79 | +0·74 |
| [δ Aquilæ] | 4 | 19 19 2·58 | 2·65 | −0·07 | 4 | + 2 51 41·76 | 42·18 | −0·42 |
| γ Aquilæ | 11 | 19 40 10·44 | 10·49 | −0·05 | 16 | +10 18 10·37 | 11·50 | −1·13 |
| α Aquilæ | 14 | 19 44 32·22 | 32·33 | −0·11 | 27 | + 8 31 55·29 | 55·81 | −0·52 |
| $\alpha^1$ Capricorni | 1 | 20 10 32·88 | 33·15 | −0·27 | ... | ... | ... | ... |
| $\alpha^2$ Capricorni | 7 | 20 10 57·02 | 57·10 | −0·08 | 6 | −12 56 23·19 | 22·60 | −0·59 |
| α Cephei | 6 | 21 15 31·82 | 31·39 | +0·43 | 27 | +62 2 36·96 | 36·21 | +0·75 |
| β Cephei | 4 | 21 26 60·25 | 59·97 | +0·28 | 21 | +69 59 55·67 | 55·13 | +0·54 |
| α Aquarii | 8 | 21 59 12·55 | 12·58 | −0·03 | 7 | − 0 56 26·86 | 26·16 | −0·70 |
| α Piscis Aust. | 2 | 22 50 34·52 | 34·40 | +0·12 | 1 | −30 17 62·55 | 59·92 | −2·63 |
| α Pegasi | 7 | 22 58 23·10 | 23·20 | −0·10 | 8 | +14 31 0·40 | 2·73 | −2·33 |
| [γ Piscium] | 5 | 23 10 31·81 | 31·76 | +0·05 | 5 | + 2 34 59·04 | 59·78 | −0·74 |
| [ι Piscium] | 5 | 23 33 21·84 | 22·16 | −0·32 | 7 | + 4 55 58·00 | 57·55 | +0·45 |
| [ω Piscium] | 4 | 23 52 44·35 | 44·41 | −0·06 | 4 | + 6 9 15·34 | 16·97 | −1·63 |
| Polaris | 54 | 1 11 58·56 | 57·44 | +1·12 | 98 | +88 37 36·50 | 36·65 | −0·15 |
| δ Ursæ Min. | 4 | 18 13 36·29 | 37·61 | −1·32 | 56 | +86 36 23·85 | 2·81 | +1·04 |

*Observations of Occultations of Stars by the Moon, 1874 and 1875, (with the deduced Equations between the Errors of the Lunar Elements); and of Phenomena of Jupiter's Satellites in 1875: made at the Radcliffe Observatory, Oxford.*

(*Communicated by the Radcliffe Observer.*)

*Occultations.*

| No. | Day of Observation. | Phenomenon. | Moon's Limb. | Oxford Mean Solar Time. h m s | Observer. |
|---|---|---|---|---|---|
| | 1874. | | | | |
| 1 | Oct. 22 | Disapp. of 27 Piscium | Dark | 12 1 22·2 | K |
| 2 | Dec. 16 | ,, 29 Piscium | ,, | 5 34 10·1 | L & K |
| 3 | 19 | ,, $\pi$ Arietis | ,, | 11 8 27·6 | K & B |
| | 1875. | | | | |
| 4 | Jan. 16 | Disapp. of $\tau^2$ Arietis | Dark | 7 51 43·2 | L & B |
| 5 | 20 | ,, $c$ Geminorum | Imperfect | 12 30 38·1 | K |
| 6 | May 12 | ,, 37 Leonis | Dark | 11 2 19·6 | K & B |

*Notes.*

1874. Oct. 22. Passing clouds made the actual moment of disappearance difficult to estimate.

Dec. 16. The disappearance was instantaneous (L. and K.).

19. The disappearance was instantaneous (K.). For an instant just before disappearing, the star became blurred, and then vanished instantaneously (B.).

1875. Jan. 16. The disappearance was instantaneous. Passing clouds (L. and B.).

20. The observation good, though both the Moon and star were faint on account of thin cloud.

May 12. The disappearance was instantaneous, and the observation good (K.). The disappearance was instantaneous (B.).

In the following table of the errors of lunar elements resulting from the occultations, the Greenwich notation is used, and the elements of the *Nautical Almanac* are used uncorrected. All the computations have been made by Mr. Main by the method given in his treatise on *Spherical and Practical Astronomy*.

The observations are referred to by the Nos. of reference given above.

1, $+ 8''\cdot97 = + 0\cdot627 \times e - 0\cdot778 \times f - 0\cdot627 \times x + 0\cdot778 \times y - 0\cdot489 \times t + 3\cdot099 \times m - 0\cdot993 \times n.$

2, $+ 7''\cdot59 = + 0\cdot493 \times e - 0\cdot870 \times f - 0\cdot493 \times x + 0\cdot870 \times y - 0\cdot412 \times t + 2\cdot325 \times m - 0\cdot963 \times n.$

3, $+ 10''\cdot47 = + 0\cdot950 \times e - 0\cdot086 \times f - 0\cdot950 \times x + 0\cdot088 \times y - 0\cdot447 \times t + 1\cdot465 \times m - 0\cdot987 \times n.$

The computations of those in 1875 are not yet completed.

## *Phenomena of Jupiter's Satellites.*

| Day of Obs. 1875. | Satellite. | Phenomenon. | Instrument. | Oxford Mean Solar Time of Observation. h m s | Greenwich Mean Solar Time from N.A. h m s | Observer. |
|---|---|---|---|---|---|---|
| April 5 | I. | Trs. egr. first contact | 10-ft. tel. | 12 21 47·2 | | |
| | | ,, bisection | ,, | 12 24 16·8 | 12 32 | K |
| | | ,, last contact | ,, | 12 27 16·3 | | |
| | III. | Ecl. disap. began to lose brightness | ,, | 12 59 31·0 | | |
| | | ,, final disap. | ,, | 13 6 4·9 | 13 6 27·5 | ,, |
| 12 | I. | Trs. ingr. first contact | ,, | 11 56 51·2 | | |
| | | ,, bisection | ,, | 11 58 50·9 | 12 5 | ,, |
| | | ,, last contact | ,, | 12 1 20·5 | | |
| 13 | I. | Occ. disap. last contact | ,, | 9 15 6·5 | 9 19 11 6 | L |
| | I. | Occ. reap. last contact | ,, | 11 33 33·3 | 11 34 | ,, |
| 20 | II. | Trs. egr. first contact | ,, | 8 36 28·9 | | |
| | | ,, last contact | ,, | 8 41 28·1 | 8 43 | ,, |
| | I. | Occ. disap. first contact | ,, | 10 57 55·6 | | |
| | | ,, bisection | ,, | 11 0 5·2 | 11 6 | ,, |
| | | ,, last contact | ,, | 11 2 34·8 | | |
| | I. | Ecl. reap. first seen | ,, | 13 16 17·8 | 13 20 53·9 | ,, |
| 27 | II. | Trs. ingr. bisection | ,, | 8 28 8·8 | | |
| | | ,, last contact | ,, | 8 31 8·3 | 8 31 | K |
| | II. | Trs. egr. first contact | ,, | 10 51 48·2 | | |
| | | ,, bisection | ,, | 10 53 47·9 | 10 56 | ,, |
| | | ,, last contact | ,, | 10 55 47·6 | | |
| | I. | Occ. disap. first contact | ,, | 12 41 30·1 | | |
| | | ,, bisection | ,, | 12 43 29·8 | 12 50 | ,, |
| | | ,, last contact | ,, | 12 45 29·5 | | |
| 28 | I. | Trs. ingr. first contact | ,, | 9 53 30·7 | | |
| | | ,, bisection | ,, | 9 55 20·4 | | L |
| | | ,, last contact | ,, | 9 57 55·0 | | |
| | | ,, first contact | Heliom. | 9 51 40·5 | 9 59 | |
| | | ,, bisection | ,, | 9 54 55·0 | | B |
| | | ,, last contact | ,, | 9 57 39·5 | | |
| | I. | Sh. ingr. last contact | 10-ft. tel. | 10 14 47·2 | 10 15 | L |
| | I. | Trs. egr. first contact | ,, | 12 0 44·8 | | |
| | | ,, last contact | ,, | 12 6 48·8 | 12 11 | ,, |
| | I. | Sh. egr. first contact | ,, | 12 13 37·7 | | |
| | | ,, last contact | ,, | 12 20 16·6 | 12 28 | ,, |

| Day of Obs. 1875. | Satelite. | Phenomenon. | Instrumeht. | Oxford Mean Solar Time of Observation. h m s | Greenwich Mean Solar Time from N.A. h m s | Observer. |
|---|---|---|---|---|---|---|
| April 29 | I. | Ecl. reap. first seen | ,, | 9 38 34·4 | 9 43 12·7 | K |
| | | ,, full brightness | ,, | 9 45 58·2 | | |
| May 5 | I. | Trs. ingr. first contact | ,, | 11 35 41 0 | 11 44 | ,, |
| | | ,, bisection | ,, | 11 37 40·7 | | |
| | | ,, last contact | ,, | 11 39 40·4 | | |
| 11 | II. | Trs. ingr. last contact | ,, | 13 6 18·0 | 12 59 | L |
| 13 | I. | Occ. disap. first contact | ,, | 10 39 26·2 | 10 45 | K |
| | | ,, bisection | ,, | 10 41 25·9 | | |
| | | ,, last contact | ,, | 10 42 55·7 | | |
| | II. | Ecl. reap. first seen | ,, | 10 56 46·8 | 11 4 | ,, |
| | | ,, full brightness | ,, | 11 0 22·7 | | |
| 14 | I. | Trs. egr. first contact | ,, | 9 59 44·3 | 10 8 | L |
| | | ,, last contact | ,, | 10 4 23·5 | | |
| | I. | Sh. egr. first contact | ,, | 10 34 58·5 | 10 46 | ,, |
| | | ,, last contact | ,. | 10 39 27·8 | | |
| | | ,, first contact | Heliom. | 10 34 18·1 | | B |
| | | ,, last contact | ,, | 10 38 17·4 | | |
| 18 | III. | Occ. disap. first contact | 10-ft. tel. | 9 52 57·0 | 10 1 | L |
| | | ,, bisection | ,, | 9 57 36·2 | | |
| | | ,, last contact | ,, | 10 3 55·2 | | |
| | III. | Occ. reap. last contact | ,, | 12 10 45·4 | 12 9 | ,, |
| | III. | Ecl. disap. | ,, | 12 53 58·2 | 12 57 21·1 | ,, |
| | | ,, | ,, | 12 54 18·1 | | |
| 20 | II. | Occ. disap. first contact | ,, | 9 32 51·7 | 9 42 | K |
| | | ,, bisection | ,, | 9 35 51·2 | | |
| | | ,, last contact | ,, | 9 39 5·7 | | |
| 25 | III. | Occ. disap. first contact | ,, | 13 11 8·4 | 13 26 | L |
| | | ,, last contact | ,, | 13 21 6·8 | | |
| 27 | II. | Occ. disap. bisection | ,, | 11 58 46·5 | 12 3 | K |
| | | ,, last contact | ,, | 12 1 16·1 | | |
| June 5 | II. | Trs. egr. first contact | ,, | 11 29 40·9 | 11 33 | ,, |
| | | ,, bisection | ,, | 11 32 40·4 | | |
| | | ,, last contact | ,, | 11 35 39·9 | | |
| 12 | III. | Trs. ingr. first contact | ,, | 9 58 20·9 | 10 7 | ,, |
| | | ,, bisection | ,, | 10 3 20·1 | | |
| | | ,, last contact | ,, | 10 8 19·3 | | |

| Day of Obs. 1875. | Satellite. | Phenomenon. | Instrument. | Oxford Mean Solar Time of Observation. h m s | Greenwich Mean Solar Time from N.A. h m s | Observer. |
|---|---|---|---|---|---|---|
| June 12 | II. | Trs. ingr. first contact | ,, | 11 25 7·0 | | |
| | | ,, bisection | ,, | 11 28 6·5 | 11 26 | K |
| | | ,, last contact | ,, | 11 31 6·0 | | |
| 23 | III. | Ecl. reap. first seen | ,, | 10 41 40·7 | 10 48 0·4 | ,, |
| | | ,, full brightness | ,, | 10 46 20·0 | | |

*Notes.*

April 5. J. III. Ecl. disapp. The satellite gradually faded to the merest point of light before finally disappearing.
12. Cloudy.
13. The phenomenon at disapp. was given as an eclipse in the *Nautical Almanac*, but it was observed as an occultation.
20. J. II. Trs. egr. The planet unsteady.
27. J. II. Trs. ingr. Cloudy.
28. The planet very tremulous as seen in the Heliometer.

May 5. Cloudy.
11, and 18 Occ. reap. Clouds prevented the previous phases of the phenomenon being observed; the last contact tolerably satisfactory.
J. III. Ecl. disap. The planet and satellites were seen only by glimpses on account of the sky, and the satellites disappeared between the two times noted.
25. Jupiter "boiling."
27. Cloudy.

June 5. A very bad and very tremulous image of the planet.

The initials L., K., B., are those of Mr. Lucas, Mr. Keating, and Mr. Bellamy. The instruments used were the Heliometer with power of 200, and the 10-foot telescope with power of 160.

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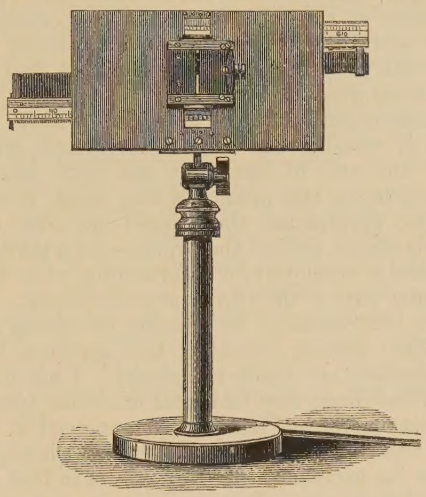
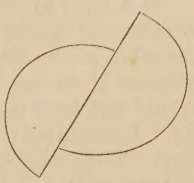
*On a Diaphanometer.* By Captain W. de W. Abney, R.E.

Though perhaps not strictly within the field of Astronomy, I have ventured to bring before the notice of the Society this evening a small instrument which I have called a Diaphanometer, and which can also be used as a photometer. The instrument itself, in its simplest form, consists of a wedge of dark glass corrected for refraction, together with a means of placing any diaphanous or translucent substance in juxtaposition with it. A luminous body in rear enables the experimenter to judge through which part of the wedge the same intensity of light penetrates, as it does through the diaphanous body. The instrument exhibited consists of smoke-coloured wedges, moving with a rack-and-pinion motion, with a scale attached behind a face on which is placed an adjustable slit. Over these wedges can be placed a strip of the substance whose translucency is to

be estimated; which can likewise be moved by a rack-and-pinion, so as to bring any portion of it opposite the slit. I have used the instrument extensively in measuring the opacity of different



films (particularly photographic); and also, by the aid of a prism of total reflection placed immediately in rear of the top part of the slit, and substituting a wedge for the translucent body (thus having wedges at the top and bottom of the slit). By desire of the Royal Engineer Committee a large number of determinations of the illuminating powers of different lights have been made. These determinations have proved to be at least as accurate as when using the ordinary photometers; and the method has, it seems to me, the advantage of compactness. When using the instrument to measure translucency, the slit is generally illuminated by means of a screen of very thin tissue paper, on which is thrown any convenient light; either a portion of the spectrum (if it be required to judge of the translucency for any particular colour) or the sodium light. The wedge is moved by the rack-and-pinion till the lights through the top-half and the bottom-half of the slit appear of equal intensity. The scale is then read off, and the intensity of transmitted light is at once known. The plan adopted of ascertaining when the two halves of the slit are of the same brightness is as follows:—a split lens is used as the object-glass of a small telescope, the optical centres being separated sufficiently to give two defined images.



In that exhibited, made of cardboard, the separation is about $\frac{1}{4}$-inch. When the line of division of the two halves of the object-glass is inclined at a small angle to the line of the

slit, two distinct images of the slit are obtained, the top portion of one being side by side with the bottom portion of the other. As these appear on a black background, it is very easy to judge when the two portions appear of equal intensity. Of course, if the two portions of the object-glass be not exactly equal, an untrue result would be obtained; but by turning the object-glass through 180°, another reading is obtained, and the mean of the two intensities gives the truth.

Another instrument is here to which I have applied the same method of reading. It is a Spectroscope, with a slit on each side of the axis of the tube, the light being reflected through the collimator and prisms by two small prisms of total reflection. Two spectra are thus placed one over the other, a moveable slit is placed behind the prisms, and a telescope similar to that described is employed for ascertaining when the intensity of any particular part of the two spectra are equal. In this case the intensities are equalised by opening or closing one or other of the two slits; whence, knowing the aperture between the jaws, the intensities are easily calculated. I am in hopes that this, in a modified form, may be useful in stellar spectroscopy.

The Diaphanometer has lately been employed in determining photographic irradiation as applied to solar photography; and I trust that by its use some involved points in that subject may be cleared up definitively. It is on these grounds alone that it has been submitted to the notice of the Society. I should be glad if any Fellow would offer any suggestion as to its improvement. I may mention that, when first the instrument was used the intensities were judged without any telescope; however, greater accuracy is ensured by using it. I have to thank Mr. Browning for the care he has taken in carrying out my designs, both in this and the double spectroscope.

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## *Note on the Suspected Variability of B.A.C.* 740, 4,166, *and* 4,193.

By Colonel Tennant.

B.A.C. 740 was wanted, but could not be found by Capt. Strahan or myself in our Transits (3-in aperture). It was also invisible in the Equatoreal finder, but the B.A.C. stars on the two sides of it in the field were seen well. B.A.C. 4,166 and 4,193 would not bear the slightest illumination in my Transit on April 24. I estimated them at 8 mag. and 8.5 mag. respectively on that day. They were certainly far below 6 mag., which I can easily observe with full illumination.

Possibly all these stars are variable.

1875, *May* 5.

*Additional Note on the Proper Motion of B.A.C.* 793 (*Piazzi II.* 123.) By E. Dunkin, Esq.

In my Note inserted in the last number of the *Monthly Notices*, I remarked that the large proper motion of B.A.C. 793 had for some time attracted the attention of observers, even before 1852. I ought, however, to have added that the late Professor Argelander has included this star in his Catalogue of 250 stars having more than the average proper motion, (*Untersuchungen über die Eigenbewegungen von* 250 *Sternen*) which is published in vol. vii. of the *Bonn Observations* (Bonn, 1869). On page 54 of this work, a comparison is given of the places found in various Star-Catalogues, from Lalande with the epoch of observation 1794·00 to the Paris Catalogue with epoch 1864·92. Very great irregularities are shown in the separate results deduced from these observations, and as the intervals between the epochs are generally small, any variability in the proper motion that may exist is probably masked by the peculiar errors of the different Catalogues. The continued observation of this star is therefore highly important.

*Kenwyn, Kidbrooke, Blackheath,*
1875, *June* 10.

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*Elements of τ Ophiuchi.* By Dr. W. Doberck.

Node = 67° 1′
$\gamma$ = 36° 26′
$\lambda$ = 46° 8′
$e$ = 0·6055
P = 217·87 yrs.
T = 1818·50
$a$ = 1″·193

*Col. Cooper's Observatory,*
1875, *June.*

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*Elements of γ Leonis, Algieba.* By Dr. W. Doberck.

Node = 111° 50′
$\gamma$ = 43° 49′
$\lambda$ = 194° 22′
$e$ = 0·7390
P = 402·62 yrs.
T = 1741·11
$a$ = 2″·087

*Col. Cooper's Observatory,*
1875, *June* 16.

*Note on the Discovery of three Minor Planets:* (144), (145) *and* (146). By E. Dunkin, Esq.

Telegrams have been received by the Astronomer Royal from the Smithsonian Institution, announcing the discovery of two minor planets by Dr. C. H. F. Peters, of the Litchfield Observatory, Clinton, New York. The assumed position of (144) given in the telegram for midnight on June 4, 1875, is R.A. $17^h\ 21^m$ and N.P.D. 113° 21′: magnitude the eleventh. In the second telegram dated June 5, the position of (145) for midnight on that day is given as R.A. $17^h\ 14^m$, and N.P.D. 113° 8′: motion southwards, and magnitude the twelfth.

A telegram has also been received from the Marseilles Observatory announcing the discovery of Minor Planet (146) on the evening of June 8, by M. Borrelly.

(144) was observed at Berlin on June 6, and at Bilk on June 8.

*Blackheath,*
1875, *June* 10.

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*The Johnson Memorial Prize.*

The Trustees of the Johnson Memorial Prize for the Encouragement of the Study of Astronomy and Meteorology propose the following subject for an Essay:—

*The History of the successive Stages of our Knowledge of Nebulæ, Nebulous Stars, and Star-clusters, from the time of Sir William Herschel.*

The Prize is open to all Members of the University of Oxford; and consists of a Gold Medal of the value of Ten Guineas, together with so much of the dividends for four years on £338 Reduced Annuities as shall remain after the cost of the Medal and other expenses have been defrayed.

Candidates are to send their Essays to the Registrar of the University under a sealed cover, marked "Johnson Memorial Prize Essay," on or before the 31st day of March 1879; each candidate concealing his name, distinguishing his Essay by a motto, and sending at the same time his name sealed up under another cover with the same motto written upon it.

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Errata.

p. 357, line 11, for "0″·43" read "1″·43."

p. 358, line 3 of figures, for "0·124" read "0·144."

p. 359, last line but 1 of figures, for "17·3" read "1·73."

p. 360, last line but 8, for "$0^s$·40" read "$0^s$·04."

p. 373, last line but 7, for "*b* Coronæ" read "$\sigma$ Coronæ."